# Yayoi UEDA* & Makoto NISHIDA*: **On the petrified pine leaves from the Upper Cretaceous of Hokkaido****

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(Pl. V-VII)

Petrified leaves belonging to the genus *Pinus* from the Mesozoic have been reported hitherto of only six species besides unidentified five species. All of them have been collected from the Middle or Upper Cretaceous of North America or Japan. These are listed as follows. A monophyllous species, *Pinus yezoensis* Stopes & Kershaw (1910), was found from the Upper Cretaceous of Hokkaido, Japan. *P. triphylla* Hollick & Jeffrey (1909) from the Middle Cretaceous of North America and *P. flabellifolia* Ogura (1932) from the Upper Cretaceous of Hokkaido are three-leaved pines. *P. tetraphylla* Jeffrey (1908) from the Middle Cretaceous of North America is a sole species of four-leaved pine. *P. quinquefolia* Hollick & Jeffrey (1909) from the Middle Cretaceous of North America and *P. pseudostrobifolia* Ogura (1932) from the Upper Cretaceous of Hokkaido are five-leaved pines. Besides the above, Jeffrey (1908) reported unidentified specimens which are two of two-leaved pines, one of three-leaved pines, one of five-leaved pines and two of unknown-leaved pines from the Middle Cretaceous of North America. Penny (1947) made critical studies on *P. quinquefolia* and *P. tetraphylla*, and Robison (1977) proposed emended description of *P. triphylla* and *P. quinquefolia*.

In the present paper we will describe six species, including four new petrified pine leaves which were collected by the second author and Dr. Mitsuo Suzuki, Associate Professor of Kanazawa University, from the Upper Cretaceous of Oh-Yubari, Yubari City and of Ikushumbetsu, Mikasa City, Hokkaido. Oh-Yubari is famous as a birth-place regarding the studies on petrified plants in Japan; some works on petrified plants were already reported by several authors,

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such as Stopes & Fujii (1910), Stopes & Kershaw (1910), Kershaw (1910), Ogura (1930, 1932, 1944), Nishida, M. (1974, 1981), Nishida, H. & Nishida, M. (1979), Nishida, H. (1981a, b), Nishida, M. & Nishida, H. (1982).

**Materials and method** All materials have been found out of the gravels on the river beds of Yubari- or Katsurazawa-rivers. These gravels contain ammonites belonging to *Gaudriceras*, so that these gravels may have originated in the strata of the Upper Cretaceous which has been widely piled on the both areas. The gravels bearing petrified plants consist of calciferous shale. Hence we could make micropreparations of those petrified specimens by ordinary peel method applying hydrochloric acid as etching agents.

**Pinus bifoliata** Ueda et Nishida, sp. nov. (Pl. V A)

Material: The specimen no. 73527 is a very short fragment of a detached needle leaf with semicircular outline in cross section, about 0.9 mm and 0.8 mm in lateral and radial widths respectively. This would be a needle of two-leaved pine judging from its outline. The preservation of internal structure is fairly good.

Locality: Under the damsite of Oh-Yubari, Yubari City, Hokkaido.

Horizon: Upper Yezo group (Senonian), Upper Cretaceous.

Holotype: No. 73527 is deposited in Laboratory of Phylogenetic Botany, Chiba University.

Description: A needle leaf of two-leaved pine, semicircular in outline in cross section, about 0.9 mm and 0.8 mm in lateral and radial widths respectively. Epidermis consisting of a layer of tangentially flattened small cells with thin-walls. Sunken stomata distributed on both of the ventral and dorsal surfaces. Hypodermis consisting of one or two layers of somewhat thick-walled cells. Two resin canals 40-65 $\mu$m in diameter, situated near each of the lateral corners just inside of the hypodermal layers and surrounded by a layer of small cells; epitherial cells invisible. Mesophyll consisting usually of one cell-layer, and of two cell-layers at the corners; cells of which various in shape in cross section, 35-115 (average 67) $\mu$m and 35-80 (average 59) $\mu$m in radial and tangential widths respectively; their walls undulating. Endodermis circular in outline in cross section and consisting of a layer of thin-walled round cells which are 50-83 (average 67) $\mu$m and 60-81 (average 70) $\mu$m in radial and tangential diameters respectively. Transfusion tissue consisting generally of two layers of thin-walled cells; the individual cells variable in shape and size, 40-85 (average 60) μm and 30-60 (average 44) μm in radial and tangential widths respectively. Two vascular bundles are separated by intervening of one or two layers of small parenchymatous cells. The vascular bundles not surrounded by sclerenchyma but by parenchymatous cells.

Affinity: As mentioned above, the present specimen exhibits unmistakably a structure of middle portion of a needle of the two-leaved pine, as it exhibits semicircular outline in cross section and has well differentiated tissues. The important diagnostic features of the present specimen are as follows: 1) stomata distributed on both ventral and dorsal surfaces, 2) hypodermis composed of one or two layers of somewhat thick-walled small cells, 3) two external resin canals situated just inside of the hypodermal layers near each of the lateral corners, 4) endodermis clearly discernible, 5) two vascular bundles surrounded by parenchymatous cells.

As far as the present authors know, only two species of petrified leaves of two-leaved pine have been reported by Jeffrey (1908) from the Middle Cretaceous of Staten Island, New York, U. S. A. However, he was not only unable to identify them but also did not give full description. One of them, *Pinus* sp., represented by his fig. 18, which we symbolize by species A in the following discussion, would belong to hard pine (Diploxylon) because of the presence of double vascular bundles in the needles. The other species, *Pinus* sp., represented by his fig. 19, which we symbolize by species B in the following discussion, would belong to soft pine (Haploxylon) because of the presence of single vascular bundles. The present specimen resembles Jeffrey's species A in gross morphology, in having two vascular bundles and in having two resin canals near each of the lateral corners, but it differs from the latter in exhibiting distinct endodermis instead of absence of it in the latter. Moreover, mesophyll of the present specimen usually consists of only one layer of cells which are large in diameter, and is distinctly separable from hypodermal layer. Jeffrey's species A, on the contrary, seems to have mesophyll which is composed of more than one layer of small cells and not separable from the hypodermis.

Jeffrey's two species, A and B, would represent the basal portions of the needles because of obscure stomata, small size of mesophyllous cells like those of hypodermal cells, indistinct endodermis and widely spread transfusion tissue. Moreover, both of the species A and B coincide with each other in their histology except for the number of vascular bundles. The species B having single bundle may represent more basal portion of the needle than the species A having two bundles.

Thus the present specimen which seems to represent the middle portion of a needle is uncomparable biologically with Jeffrey's species A which seems to represent the basal portion. The Jeffrey's species A, however, differs clearly from the present specimen, because of the presence of a sheath of fibrous cells arround and between the vascular bundles. Therefore we would like to register the present specimen as a new species of two-leaved pine.

**Pinus flabellifolia** Ogura (Pl. V B), Journ. Fac. Sci., Imp. Univ. Tokyo Sect: III, 2(7): 466 (1932)

Materials: The specimens nos. 73524 and 73529 are very short fragments of detached needles with fan-shaped outline in cross section, 1.1-1.2 mm and 0.7-0.9 mm in lateral and radial widths respectively and the angles of the ventral corners are about 120°, which suggests these specimens would be the three-leaved pines. The preservation of internal structure of both specimens are fairly good.

Locality: Under the damsite of Oh-Yubari, Yubari City, Hokkaido.

Horizon: Upper Yezo group (Senonian), Upper Cretaceous.

Notes: Stomata distributed on both ventral and dorsal surfaces; hypodermis composed of two or three layers of thin-walled cells and of a few thin-walled small cells scattered among the former; two external resin canals situated just inside of the hypodermis near each of the lateral corners; mesophyll composed of usually one layer of large cells with slightly undulating walls; endodermis consisting of large cells and discernible; transfusion tissue composed of one to three layers of cells; two vascular bundles separated and surrounded by small thin-walled cells, not by thick-walled fibrous cells.

The internal structure and the outline in cross section of needles of specimens nos. 73524 and 73529 coincide exactly with those of *P. flabellifolia* from the Upper Cretaceous of Yubari, Hokkaido, the same locality of the present specimens. However the latter differs from the present specimens in having hypodermis composed only of thick-walled cells and having sclerenchyma between and around two vascular bundles. We ascribe these non-agreement to the fact that the present specimens would be more basal parts of the needles than those of Ogura's type specimen. Thus we identified the present specimens with *P. flabellifolia*.

**Pinus triphylla** Hollick et Jeffrey (Pl. V C & D), Mem. New York. Bot. Gard. **3**: 14 (1909); Robison, Amer. Journ. Bot. **64**: 726 (1977).

Material: The specimen no. 73530 is a very short fragment of fascicle, 3.1 mm in diameter, consisting of three needle leaves and an apex of dwarf shoot in the center and with cataphylls arround the fascicle. Individual needle exhibits fan-shaped outline in cross section, 1.3-1.4 mm and 0.7-0.8 mm in lateral and radial widths respectively and the angle of the ventral corner is about 120°. The preservation of internal structure is not so good.

Locality: Under the damsite of Oh-Yubari, Yubari City, Hokkaido.

Horizon: Upper Yezo group (Senonian), Upper Cretaceous.

Distribution: U. S. A.: Staten Island, New York, Martha's Vineyard Island, Massachusetts. New to Japan.

Notes: A three-leaved fascicle. Each needle is fan-shaped in outline in cross section, 1.3-1.4 mm and 0.7-0.8 mm in lateral and radial widths respectively. Scales around the basal portion of needles consist of thin-walled homogenous cells and all parenchymatous without any vascular bundle nor resin canal. Dwarf shoot is surrounded by several scales. Epidermis consists only of a layer of thin-walled cells. Inside of the epidermis, there are four layers of small thin-walled cells which are 13-33 (average 22) $\mu$m in diameter. Inside of them, two or three layers of large thin-walled cells which are 33-100 (average 64) $\mu$m in diameter are situated. The former layers would correspond with hypodermis and mesophyll, and the latter layers with transfusion tissue. Resin canal not visible. Two vascular bundles in the central region of a needle are separated by intervening of two or three layers of small fibrous cells which are 15-18 $\mu$m in diameter and whole vascular bundles are surrounded by a fibrous sheath. Each bundle remains xylem only and does not phloem by erosion.

Though the present specimen exhibits somewhat different histological features from Robison's specimen, we would like tentatively to identify it with *P. triphylla*. As the present specimen has preserved as dwarf shoot apex in the center of the fascicle of needles and scales arround the fascicle, it would represent basal portion of the needls. Hence the endodermis, resin canals and mesophyllous cells with undulating walls would not be differentiated yet in the present specimen. As for petrified three-leaved pines preserving basal portion of fascicle of needles, Hollick & Jeffrey (1909) reported *P. triphylla* from the Middle Cretaceous of U.S.A., though they did not give full description, but Robison (1977) reported other specimens of it, which have better preservation than the Hollick & Jeffrey's specimens, from the Upper Cretaceous of U.S.A. and gave full description emended. Robison recognized endodermis and resin canals in his specimens, though Hollick & Jeffrey did not in their specimens. We have examined the present specimen comparing with photographs of Robison's work (Robison 1977, p. 726, fig. 4), we could not recognigze, however, any endodermal structure in the present specimen as well as in the figure of Robison's work. As far as we examined, the present specimen would seem to be identical with *P. triphylla*.

**Pinus pseudoflabellifolia** Ueda et Nishida, sp. nov. (Pl. V E)

Material: The specimen no. 73531 is a short fragment of a needle exhibiting fan-shaped outline in cross section, 1.6 mm and 0.7 mm in lateral and radial widths respectively. As the angle of ventral corner is 150°, the present specimen would be a needle of three-leaved pine. Preservation of internal structure is fairly good.

Locality: Under the damsite of Oh-Yubari, Yubari City, Hokkaido.

Horizon: Upper Yezo group (Senonian), Upper Cretaceoes.

Holotype: No. 73531 is deposited in the Laboratory of Phylogenetic Botany, Chiba University.

Description: A needle of three-leaved pine, fan-shaped in outline, 1.6 mm and 0.7 mm in lateral and radial widths respectively. The angle of ventral corner is 150°. Epidermis erroded, hence stomata not visible. Hypodermis consisting of two or three layers of thick-walled cells. Only one resin canal, 31–40 $\mu$m in diameter, situated near one of the lateral corner just inside of the hypodermal layers and surrounded by a layer of small cells; epitherial cells invisible. Mesophyll composed of two or three layers of cells which are circular or elliptical in shape in cross section, 50–80 (average 60) $\mu$m and 45–70 (average 56) $\mu$m in radial and tangential diameters respectively and their walls undulating; these cells are stuffed with brown substances by which these cells are easily distinguished from endodermis. Endodermis is circular in outline in cross section and consists of a layer of thin-walled rectangular or elliptical cells which are 45–55 (average 48) $\mu$m and 50–85 (average 75) $\mu$m in radial and tangential diameters respectively. Transfusion tissue consists of two or three layers of thin-walled cells; the shape is various and size of individual cells is 30–85 (average 53) μm and 25–75 (average 45) μm in radial and tangential diameters respectively. In the center of needle, a mass of thick-walled cells, 20–28 (average) μm and 15–23 (average 19) μm in long and short diameters respectively in cross section, are pesent instead of vascular bundle.

Affinity: The present specimen exhibits fan-shaped outline in cross section. Though its angle of ventral corner is about 150° which is wider than that of a usual needle of three-leaved pine, we would consider that it was a modified needle of three-leaved pine. The most outstanding features of the present specimen are as follows: 1) hypodermis composed of two or three layers of thin-walled cells, 2) resin canal external, situated just inside of the hypodermal layers, 3) mesophyll composed of two or three layers of cells with undulating walls, 4) endodermis clearly discernible, 5) transfusion tissue composed of two or three cell layers, 6) vascular bundle undiferentiated and 7) a mass of sclerenchymatous cells in the central part instead of vascular bundle.

The present specimen seems to be distal portion of the needle, for vascular bundle is hardly differentiated inspite of being well differentiated in other tissues, i.e. mesophyll and endodermis etc. We therefore could not decided whether the present specimen resembles *P. triphylla* or *P. flabellifolia* in gross histology except for vascular bundle; especially both species have sclerenchymatous cells between and around the vascular bundles and exhibit external position of resin canals. Moreover, hypodermis composed of two or three layers of thick-walled cells in the present specimen is similar to that of *P. flabellifolia*. However, the present specimen differs from *P. flabellifolia* in having mesophyll of two or three cell layers instead of only one layer in the latter. The present specimen has mesophyll composed of two or three cell-layers in spite of its distal portion. It seems to have two or more thick cell layers in mesophyll of the middle portion of the needle in the present specimen. The present specimen differs also from *P. triphylla* in having thin-walled endodermis instead of thick-walled ones in the latter (cf. Robison 1977) and in having very large diameter of sclerenchymatous cells (19–24 μm) instead of smaller ones (15–18 μm) in the latter. Thus the present specimen would be a new species, though it would leave a doubt that the present specimen may be the most distal portion of *P. flabellifolia*.

**Pinus pachydermata** Ueda et Nishida, sp. nov. (Pl. V F, G; VI A, B)

Material: The specimen no. 73545 is a short fragment of a detached needle showing fan-shaped outline in cross section, 1.0-1.4 mm and about 0.8 mm in lateral and radial widths respectively and the angle of ventral corner is about 120°. The angle would suggest that the present specimen is a needle of three-leaved pine. The preservation of internal structure is fairly good. The specimen is examined by vertical section as well as cross section.

Locality: Kumaoi-zawa, Ikushumbetsu, Mikasa City, Hokkaido.

Horizon: Upper Yezo group (Senonian), Upper Cretaceous.

Holotype: No. 73545 is deposited in the Loboratory of Phylogenetic Botany, Chiba University.

Description: A needle of three-leaved pine exhibiting fan-shaped outline in cross section, 1.0-1.4 mm and 0.8 mm in lateral and radial widths respectively. Epidermis eroded and stomata invisible. Hypodermis very thick, 65-90 $\mu$m in thickness, which consists of about six layers of small cells, which are fairly long fibrous and thick-walled cells. Resin canal invisible. Mesophyll consists usually of one cell-layer, and two cell-layers at the corners; cells of mesophyll polygonal or tangentially flattened rectangular in shape in cross section, 15-32 (average 22) $\mu$m and 50-60 (average 54) $\mu$m in radial and tangential widths respectively, and cells at the corners somewhat larger, 65-70 (average 68) $\mu$m and 60-80 (average 70) $\mu$m in radial and tangential diameters respectively, and vertical length of cells is shorter than radial and tangential diameters like mesophyllous cells of median portion of needles in living *Pinus*. Endodermis invisible. Transfusion tissue spread widely, contacts directly with mesophyll, and consists of two layers of large thin-walled cells on the phloem side, three cell layers on the xylem side and five cell-layers at the lateral corners; cells of transfusion tissue are rounded or elliptically polygonal in shape in cross section, 37-80 (average 62) $\mu$m and 25-95 (average 62) $\mu$m in radial and tangential widths respectively, and square or vertically short rectangular in shape in vertical section, mostly 40-70 $\mu$m in vertical length, pitted only on the vertical walls; thick-walled cells which are of same size as thin-walled cells scattered in transfusion tissue. Two vascular bundles are separated by intervening of three layers of small fibrous cells which are 15-18 $\mu$m in diameter. Fibrous cells surround the divided vascular bundles and make a heart-shaped sheath in cross section. They are three cell layers on the phloem side and five to six cell layers on the xylem side. The phloem not preserved. The xylem exhibits about ten tracheids thick; bordered pits on radial walls of tracheids are circular, arranged separately in one row.

Affinity: As mentioned above, the present specimen exhibits unmistakably a structure of a needle of three-leaved pine. The important diagnostic characters of the present specimen are as follows: 1) very thick hypodermis composed of about six layers of thin- and thick-walled small cells, 2) resin canal invisible, 3) endodermis invisible, 4) transfusion tissue spread widely and composed of two or three cell-layers, 5) two vascular bundles separated by small fibrous cells and surrounded also by them forming a heart-shaped sheath in cross section.

As far as the living pine species examined (*P. thunbergii*, *P. densiflora*, *P. cembroides*, *P. echinata*, *P. sylvestris* and *P. paruviflora*) the endodermis and resin canal are differentiated and discernible in the portion in which mesophyllous cells have undulate walls. However, the present authors could not recognize any endodermal structure nor resin canal in the present specimen, though it has undulating mesophyllous cells. We could not know whether differentiations of these structures are delayed or these structures are not differentiated in the present specimen, as our examined material is only one and very short fragment. However, it seems to be mature one, for it has undulating walls in mesophyllous cells. The present specimen is characteristic in having very thick hypodermis which has not been hitherto observed in any species of petrified three-leaved pines. Thus the present authors would like to register the present specimen as a new species, *P. pachydermata*. Specific epithet originates in its thick hypodermis.

**Pinus pseudotetraphylla** Ueda et Nishida, sp. nov. (Pl. VI C-F; VII A~F)

Materials: The specimens nos. 73544 and 73509 are short fragments of the fascicles of four-leaved pines, 4-5 mm long. The needles exhibit fan-shaped outline in cross section, 1.6-1.9 mm and 1.2-1.3 mm in lateral and radial widths respectively and the angle of ventral corners is 90°. No. 73544 is a fascicle of four needles without scales around them and lacks one needle by erosion. The preservation of internal structure is fairly good. No. 73509 has preserved four needles in the fascicle which includes terminal portion of dwarf shoot and is surrounded by several scales. The internal structure of this is not always well preserved. Both specimens are examined by cross and longitudinal sections.

Locality: Nos. 73544 and 73509, Kumaoizawa, Ikushumbetsu, Mikasa City, Hokkaido.

Horizon: Upper Yezo group (Senonian), Upper Cretaceous.

Holotype: No. 73544; paratype, No. 73509. They are deposited in the Laboratory of Phylogenetic Botany, Chiba University.

Description: The fascicles of four-leaved pines, surrounded by several scales. The internal structure of scale is obscure because of ill preservation. Epidermis of needle consists of a layer of square or polygonal small cells with thin walls. Stomata invisible. Hypodermis very thick, 100 $\mu$m in radial thickness, consisting of about six layers of cells which are thin and fairly long fibrous; most of cells are thin-walled and thick-walled cells are intermingled among them. Three resin canals, 48–100 $\mu$m in diameter, situated just inside of the hypodermal layers near the lateral and ventral corners and surrounded by a layers of small cells; epitherial cells invisible. Mesophyll is usually one cell-layer, but two at the corners. Mesophyllous cells are tangentially long polygonal in shape in cross section, 24–33 $\mu$m in radial diameter; tangential diameter is not measured because of ill preservation, and they are rectangular in shape in longitudinal section, 75–92 $\mu$m in vertical length, and their walls undulating. Endodermis invisible. Transfusion tissue spreads widely, two cells thick on the phloem side and three to five on the xylem side, and contacts directly with mesophyll. Cells of transfusion tissue arranged like tiles, circular or polygonal in shape in cross section, 28–70 (average 46) $\mu$m and 25–85 (average 54) $\mu$m in radial and tangential diameters respectively, with thin walls, and square or vertically long rectangular in shape in longitudinal section, 35–150 $\mu$m in length, and appear to have been pitted only on vertical walls. Single vascular bundle present at the level that individual leaf adheres each other on ventral face, and two bundles present at distal portion of needle. Two vascular bundles separated from each other by three layers of thin fibrous cells, and surrounded by fibrous cells of three to four layers on the phloem side and four to seven on the xylem side, forming a fan-shaped sheath in cross section. These fibrous cells are differentiated between two vascular bundles at first and become to surround the whole vascular bundles in further development. Single vascular bundle in the basal portion of needle is devoid of fibrous sheath. Transition from the transfusion tissue to the fibrous sheath is gradual, because the elements of the transfusion tissue adjacent to the sheath resemble the fibrous cells in gross morphology, namely they are small thick-walled and vertically fairly long rectangular in shape. Phloem not preserved. Protoxylem consists of scalariform tracheids and the metaxylem consists of pitted tracheids with circular bordered pits which are arranged separately in one row.

Affinity: As mentioned above, the present specimens are four-leaved pines. The important diagnostic characters of the present specimens are as follows: 1) very thick hypodermis composed of about six layers of thin- and thick-walled small cells, 2) three external resin canals situated just inside of the hypodermal layers near each lateral and ventral corners, 3) mesophyll composed of only one layer of cells with undulating walls, 4) endodermis invisible, 5) transfusion tissue spread widely and composed of two layers of cells on the phloem side and three to five layers of cells on the xylem side, 6) two vascular bundles separated by small fibrous cells and surrounded also by the fibrous cells forming a fan-shaped sheath in cross section.

Only one species, *P. tetraphylla*, has been hitherto reported as a petrified four-leaved pine from the Cretaceous of North America by Jeffrey (1908) and Penny (1947). The present specimens resemble closely *P. tetraphylla* in having two vascular bundles, thin fibrous cells between and around the vascular bundles, and widely spread tranfusion tissue. Jeffrey's and Penny's specimens of *P. tetraphylla* seem to represent the basal portion of a fascicle of four needles, as individual needle adheres to each other ventral side. The basal portion of the present specimens are compared with that of *P. tetraphylla*, and we have been conscious of the differences between the both. The size of each needle of the present specimens is 1.6–1.9 mm and 1.1–1.3 mm in lateral and radial widths respectively, and it is fairly larger than that of *P. tetraphylla*, 0.7–1.1 mm and 0.4–0.7 mm in lateral and radial widths respectively, namely about twice of those of *P. tetraphylla*. The size of the needles of *P. tetraphylla* was not described by Jeffrey, and hence we are obliged to measure it from the photographs in the original paper by Jeffrey (1908). The present specimens resemble *P. tetraphylla* in gross morphology except for their size. As the type specimen of *P. tetraphylla* has been lost according to Robison's report (1977), we can no longer compare the anatomy of the present specimens with that of the former and thus we are obliged to judge it by photographs in the original paper. We could recognize in Jeffrey's photographs five layers of cells in a area outside of vascular bundles of the basal portion though we could see eight to ten layers in the present specimens. Difference in size between the former and the latter does not seem to depend on the size of constituting cells of tissues but does to depend on the number of constituting cells. Thus we can not identified the present specimens with *P. tetraphylla*, but would like to register it as a new species, *P. pseudotetraphylla*, whose specific eithet originates in *P. tetraphylla*.

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## Explanation of plates V-VII

Pl. V. A: *Pinus bifoliata*, sp. nov., no. 73527, entire cross section. ×47. B: *P. flabellifolia* Ogura, no. 73524, entire cross section. ×47. C & D: *P. triphylla* Hollick & Jeffrey, no. 73530. C: three needles in fascicle. ×23. D: a part of one needle. ×47. E: *P. pseudoflabellifolia*, sp. nov., no. 73531, entire cross section. ×47. F & G: *P. pachydermata*, sp. nov., no. 73545. F: vertical section through transfusion tissue. White arrow showing bordered pits. ×211. G: entire cross section. ×47.

Pl. VI. A & B: *Pinus pachydermata*, sp. nov., no. 73545. ×66. A: vertical section. B: a half of cross section. C, D, E & F: *P. pseudotetraphylla*, sp. nov. C: magnified of the one needle showing resin canals, no. 73509. ×34. D: magnified of one needle, no. 73544. ×34. E: basal part of four needles in a fascicle, no. 73509. ×9. F: schematic figure of E.

Pl. VII. *Pinus pseudotetraphylla*, sp. nov., no. 73544. A: basal part of preserved three needles in a fascicle. ×19. B: more distal part of A. ×19. C: a part of cross section showing thick hypodermis and undulating walls of mesophyllous cells. ×94. D: another part of cross section showing transfusion tissue whose cells are pitted and fibrous tissue around and between the vascular bundles. ×94. E: vertical section of a needle. ×94. F: vertical section of dwarf shoot. ×15.

Abbreviations. ds: dwarf shoot, e: endodermis, f: fibers, h: hypodermis, ll: layers of large cells, m: mesophyll, n: needle, ph: eroded phloem, r: resin canals, s: stomata, sc: scales, sl: layers of small cells, tt: transfusion tissue, xy: xylem.

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北海道大夕張及び幾春別の上部えぞ層群から採ったマツ属の葉化石6種を報告した。そのうち4種は新種である。二葉松 *Pinus bifoliata*, sp. nov. は2本の維管束をもち，Jeffrey (1908) が報じた *Pinus* sp. A に似ているが，本種では維管束を柔組織がかこむのに対し，後者では繊維細胞がとりまいているので区別できる。白亜紀の有組織二葉松としてははじめての記載である。三葉松 *P. triphylla* Hollick et Jeffrey は北アメリカから記載されていた。日本新産である。*P. flabellifolia* Ogura (三葉松) は原標本よりも基部に近い部分の化石と思われる。*P. pseudoflabellifolia*, sp. nov. は中央に維管束の代りに厚膜組織条があるので，葉の先端部の化石と思われ，下表皮が2〜3細胞層からできており，1細胞層の *P. flabellifolia* と区別できる。*P. pachydermata*, sp. nov. は三葉松で，今迄記載されたどの三葉松よりも下表皮が厚い (約6細胞層) ので区別できる。*P. pseudotetraphylla*, sp. nov. は今迄知られていた北アメリカ産の4葉松 *P. tetraphylla* Jeffrey (1908) に似ているが，直径が約2倍あり，これは基本組織系の細胞数が多いためである。

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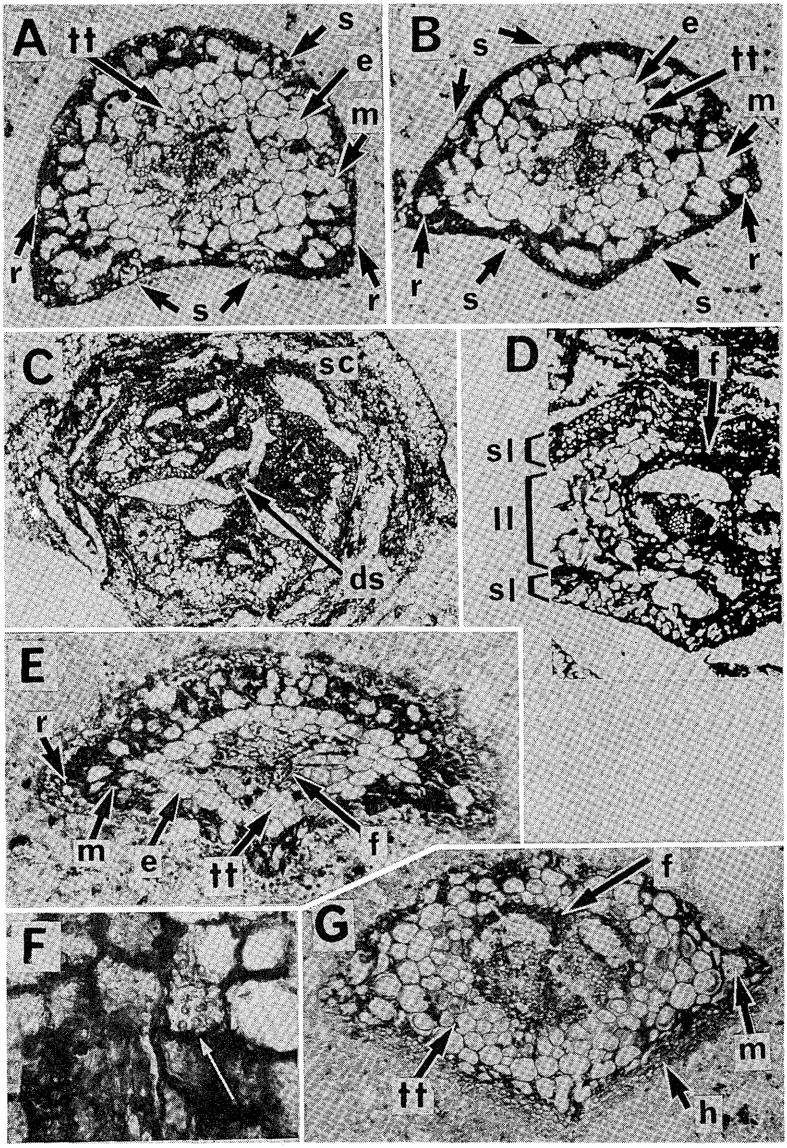
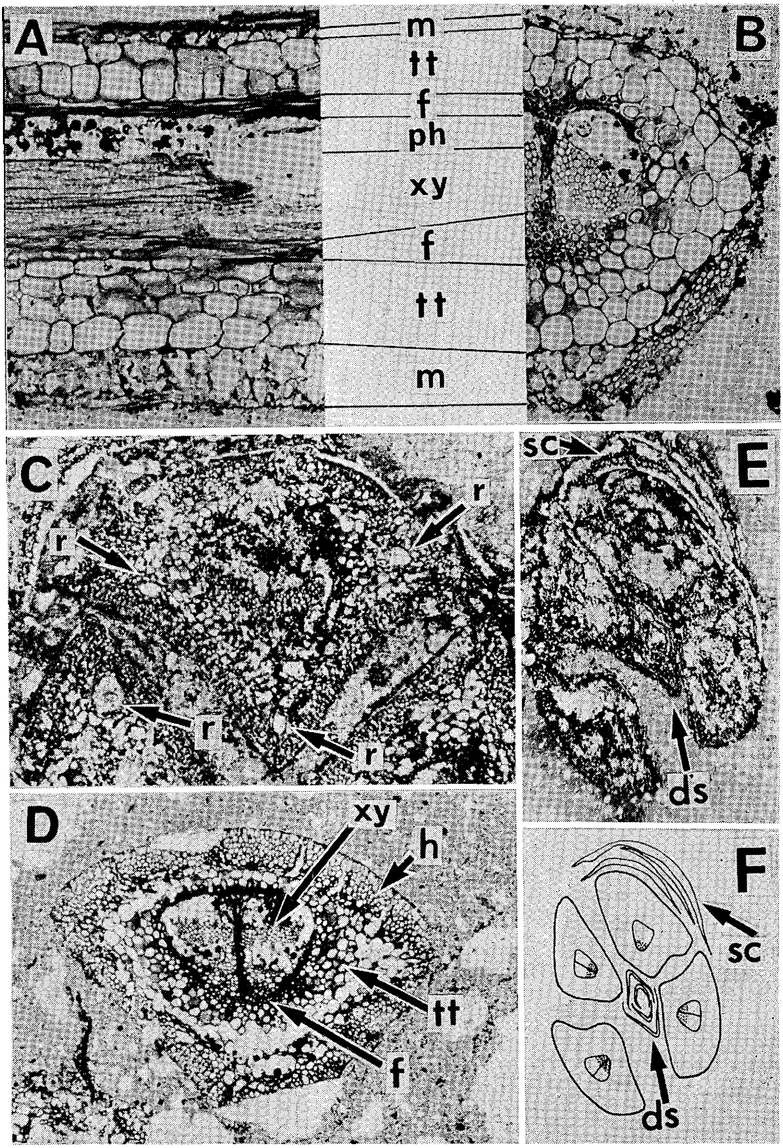
□馬場胤義（編）：**佐賀県植物目録** 266 pp. 1982. 佐賀県植物友の会. 非売品. 昭和39年に「佐賀県生物誌植物篇」が出版され，次年に佐賀県植物友の会が発足し，昨年11月には第200回の例会を重ねたという。それを契機にしてこの本が生れたが，数度にわたる発病にもかかわらず，編集に邁進された馬場さんの労は大変であったと聞いた。本書は県下の自生種2,068種のリストであるが1964年のものより1割も種数が増えているのは驚きである。それに，近頃の急な流行ともいえる各種についての主な標本の産地や日付が網羅されているのも一つの刺激になるであろうし，各種ごとに○印を附して述べられた短文が中々要を得て急所をついているのもありがたい。 （前川文夫）



Y. UEDA & M. NISHIDA: Petrified pine leaves



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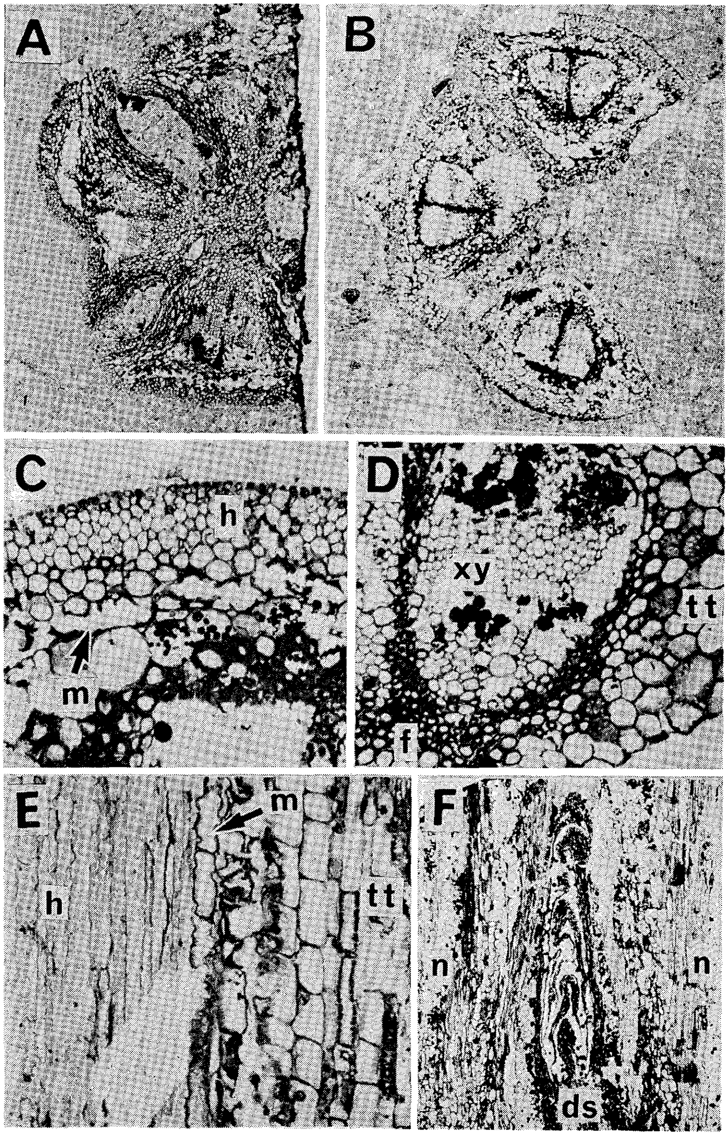

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